Comments on Revised Groundwater Source Control Construction Design Report, NW Natural GASCO Site, Portland, Oregon Dated January 2012

Comments dated May 4, 2012

The following are EPA comments on the *Revised Groundwater Source Control Construction Design Report* document, dated January 2012, prepared by Anchor QEA, LLC on behalf of NW Natural.

General Comments

1. EPA has reviewed the revised Construction Design Report (CDR) and notes that while NW Natural has made improvements to the Final Design Report (CDR precursor report) submitted May 2011, the revised document still does not provide enough description in the narrative or elaboration on key concepts and calculations to support results in many key sections. Sections in particular where issues remain are commented on in the specific comments below.

2. EPA provided NW Natural comments on the March 2011 *Segment 2 Capture Zone Field Test Report* (transmitted via e-mail on April 25, 2011) and responded to additional information from the May 2011 *Segment 2 Field Tests of the Programmable Logic Control and Variable Frequency Drive Well Pumps* (transmitted via e-mail on July 7, 2011). To date, we have not received any substantive responses to these comments. As such, NW Natural makes general statements related to the demonstration of capture effectiveness throughout the entirety of groundwater flow regime underlying the Gasco Site that EPA has not resolved with NW Natural and simply cannot agree with.

Specific Comments

1. **Section 2.1.3, page 10, third paragraph:** EPA received a technical memorandum titled *NW Natural Gasco Site: Documentation of Groundwater Model Modifications Since 2008,* dated April 12, 2012, and prepared by Anchor QEA, LLC on behalf of NW Natural. EPA understands that this memorandum constitutes Appendix F, which was empty in the January 31, 2012 CDR. Comments specific to the modeling update are presented in a separate section below titled "*Appendix F Comments*."

2. **Section 3.2.1.1, page 21, paragraphs 3 and 4, and page 22, last paragraph of section:** Although free cyanide detections are lower than total, more explanation of the implications for those areas where free cyanide detections exist is needed. Furthermore, free cyanide concentrations are noted as generally being below 10 micrograms per liter (µg/L), but there is no discussion or analysis as to what this means in terms of toxicity. A brief mention of basic statistics on detections in the last paragraph indicates only 4 out of 180 samples had detection of free cyanide, but in those 4 detections concentrations were as high as 140 µg/L and no explanation is given on the implications of this concentration level, or what

monitoring well had this high detection. Also, it appears the free cyanide data has been submitted to a variety of labs with different detection limits; some detection limits appear to be as high as 10 µg/L, while others have detection limits as low as 5 µg/L. Therefore, it is incorrect to make general conclusions about the number of detections versus samplings when there is inconsistency in laboratory detection limits within the data set.

3. **Section 3.2.1.2, page 23, paragraph 2, last sentence:** More explanation on what the significance lag time has on the hydraulic control and containment (HC&C) system is needed. This explanation is necessary to address several comments EPA presented on the May 2011 *Segment 2 Field Tests of the Programmable Logic Control and Variable Frequency Drive Well Pumps* (submitted to NW Natural in an EPA e-mail dated July 7, 2011) that related to uncertainty in the HC&C system being able to demonstrate sustained and effective capture of contaminant discharge to the river while dynamic changes occur between the groundwater and the river.

4. **Section 3.2.1.3:** This section is too limited to the discussion of hydraulic conductivity. EPA believes more information was gleaned from these Segment 2 tests and incorporated into the site groundwater MODFLOW model than just hydraulic conductivity. This information should be summarized in the narrative within this section. EPA expects the discussion to include a summary of additional hydraulic information and well performance that were discovered in Segment 2 testing.

5. **Section 3.2.1.4, page 25, paragraph following model parameter table:** EPA believes it is unconventional to ignore slug test results for a hydrostratigraphic layer represented in the model (Fill WBZ) because inputting the site specific data would throw off model calibration. The issue of the model going out of calibration may be related to a different parameter that could be creating the discrepancies between modeled and measured groundwater heads. This issue should be looked into, not ignored. Furthermore, EPA believes it is premature to state that assuming a higher hydraulic conductivity is conservative without fully understanding other critical hydraulic parameters that may be influencing groundwater heads.

6. **Section 3.2.1.4, page 26, paragraphs 2 through 4:** A groundwater flow budget is presented with an illustration of flow budget components on Figure 3-4. However, there is no documentation or calculations explaining how these flow budget values were derived. The flow budget components need to also be presented in a way that a reviewer can verify the budget components are balanced (e.g., Inputs = Outputs). This is usually shown in a water budget table. Also, some flow budget components seem to conflict with statements made in the text, or raise additional questions, for instance:

    - The narrative on anticipated interceptor trench discharges indicates flows will be 10% of the total discharge from the alluvium WBZ HC&C system (Section 3.2.2.1, page 33). However, flow from the trench is shown at 9 gallons per minute (gpm), which is only

3.5% of the total discharge shown for the HC&C. It is possible that these lower flows are the result of post site paving, but this needs to be explained/presented.

- Recharge of 45 gpm appears to be assumed to infiltrate into the fill unit; however, this may not be reasonable with the assumed paved site conditions. Again, presentation of calculations that derived these values is essential to allow for review and improve confidence that these values are correct. The component of flow that 5 gpm discharging downgradient of the wall represents should be presented. It seems relatively significant since it represents over 50% of the flow expected from the interceptor trench and may indicate that flows within the Fill hydraulically downgradient of the interceptor trench (if this is what the 5 gpm represents) need to be captured and a modification to the proposed HC&C system should occur.

7. **Section 3.2.2.1, page 32, second paragraph:** Based on the narrative in this paragraph, that essentially defers any revision or discussion on the Fill WBZ interceptor trench, EPA cannot concur with this design element of the CDR until such revision and documentation has been produced.

8. **Section 3.2.2.2.1, page 35, last bullet:** NW Natural should describe how the 8 to 5 gpm reduction in flow rates necessary for hydraulic control in the upper alluvium through the addition of extraction wells was determined. More information and calculations need to be presented so the reader can understand how the reduction in flow was determined.

9. **Section 3.2.2.2.1, pages 35 and 36, and Tables 3-4a and 3-4b:** EPA has the following comments on the analysis and presentation of material in these two tables and the accompanying narrative:

    - It is uncertain if the tested specific capacities shown in Table 3-4a have been determined from stabilization, or if drawdown continued at the end of testing. A footnote should describe and verify this.

    - Due to well losses, the production capacity of a well is not constant and varies inversely proportional with discharge. At lower rates, capacities are at maximum, but then decline at higher rates due to well losses. Therefore, maximum possible pumping rates determined directly from specific capacities during tests at much lower rates are not realistic and should not be presented as such. Additional analysis should be performed to realistically provide maximum possible pumping rates accounting for the increased effects of drawdown at higher rates due to well losses. Furthermore, maximum possible pumping rates are not relevant information, rather, the maximum pumping rate required for maintaining capture (as measured by the negative delta between the river stage and upland groundwater levels) should be evaluated. The Segment 2 pumping tests showed that higher rates were necessary for the extraction wells to meet negative deltas in the monitoring network. NW Natural should evaluate these maximum pumping rates based on applicable specific capacities estimated for these rates.

- The statement in the last sentence of the second paragraph on page 36 is fundamentally incorrect. Specific capacity does not increase with a lower pump setting. It is possible NW Natural meant to state "well capacity" instead of specific capacity, which would make the statement correct.

- Regarding the discussion at the top of page 36, it is unclear what supporting documentation exists that hollow stem auger drilling smears the borehole well more than other methods of drilling used at the site, such as sonic, or cable-tool. NW Natural should present or reference literature that supports this statement. EPA believes the low specific capacity obtained at PW-8-39 should not be ignored, just because it is low. If the specific capacity of wells were 50% less than the lowest assumed specific capacity in the table (1.0 gpm/ft of drawdown), which is still above the specific capacity determined at PW-8-39, many of the upper alluvium wells would not meet sustainable pumping rates under seasonal low groundwater conditions. This possibly will not be fully understood until additional upper alluvium wells are installed, but the limited data that exists (not ignoring PW-8-39) suggests there are capacity limitations for the upper alluvium extraction wells at certain times of the year and NW Natural should note this in the narrative and on Tables 3-4a and 3-4b as well as reiterate the contingency plan of adding additional extraction wells for such an occurrence.

10. **Section 3.2.2.2.1, page 38, first paragraph:** In Oregon Department of Environmental Quality's (DEQ) December 7, 2011 submittal (see Attachment B - EPA Specific Comments; Category 1, Item 30, EPA Comment 3**),** EPA requested that NW Natural present additional figures showing hydraulic response within the primary water bearing units (Fill, Upper Alluvium, Lower Alluvium- above and below the confining layer). The comment specifically requested that more than particle capture maps as shown on Figures 3-2a through 3-2e (e.g., modeled head maps) are needed to illustrate extraction well influence based on long-term, sustainable pumping rates. Please note that presentation of modeled heads is standard practice for instilling confidence in the particle tracks produced by the numerical model (see EPA's *A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems*, EPA 600-R-08-003, January 2008, page 23). These head maps would show drawdown and gradients developed from the extraction system that could be used to verify the selected locations of control wells and monitoring wells for controlling variable frequency drive (VFD) pumps and assessing hydraulic capture. NW Natural replied to EPA Comment 3 referenced above that "*Yes, these additional figures will be provided in the Construction Design Report.*" However, no such drawdown/modeled head maps exist in the report, only additional particle track maps for tracking contaminants originating upgradient of the extraction wells. Therefore, EPA feels, with regards to providing the necessary illustrations to evaluate monitoring well and control well locations, NW Natural has been non-responsive to EPA's referenced comment. EPA expects NW Natural to provide head maps for each stratigraphic layer under the same pumping conditions that produced the particle capture maps shown in Figures 3-2a through 3-2e.

11. **Section 3.2.2.2.1, Table 3-4b and page 38:** The analysis presented on sustainable pumping rates is deficient in terms of evaluating sustainable capture under seasonal changes. EPA understands that a range of flows will be required from the VFD pumps (this is stated in the last sentence on Page 38 of the CDR above the table embedded in the text showing predicted steady-state pumping rates), yet only the average pumping rate is presented. NW Natural should review Segment 2 pumping test data to determine the maximum flow rates and durations that were necessary to achieve control of the hydraulic gradients to the offshore piezometers (the furthest extent of hydraulic control). This information, in addition to historical water level monitoring data at the site, should then be used to determine deltas between groundwater heads and river stages under seasonal conditions when the river stage is at its lowest and groundwater gradients are at their highest. This will estimate and present the maximum extraction well flow rates and durations needed to achieve measureable gradient reversals at monitoring wells and offshore piezometers used for the hydraulic control verification. These maximum flow rates should then be evaluated against those determined as sustainable in both upper (Table 3-4b) and lower (no table provided) alluvium extraction wells to understand if deficiencies exist in the HC&C design.

12. **Section 3.2.2.2.2:** EPA has the following comments regarding this section:

    The bulleted list on page 40 should footnote that actual slot size and sand pack gradation will be determined based on actual field conditions.

    EPA notes that NW Natural justifies its selection of filter pack based on a generalized grain size analysis of 10-20 filter pack from Oglebay Norton that was provided in 2006. NW Natural should be aware that sand pack gradations vary between manufacturers and over time. Therefore, it is important to obtain current specifications of the sand pack gradation curves from the supplier of the sand pack material to be delivered on site and that a quality control check of filter pack should be conducted prior to use and placement at each extraction well. The pack should meet the specifications by the manufacturer within a tolerance of 10% for the specific gradation range type curve.

13. **Section 3.2.2.2.2, page 42, first paragraph and bullets regarding well efficiency determination:** The referenced Driscoll text presents several methods and equations for determining well efficiency. EPA comments did not recommend a specific method to calculate well efficiency to NW Natural. For clarification, NW Natural should provide a description of the methodology that was used as well as the page and section number within the Driscoll reference that presents the limiting factors of the specific analysis. Nevertheless, if NW Natural believes a particular method is deemed inappropriate, it is the responsibility of NW Natural to select a method that is appropriate for site conditions. Statements made by NW Natural that well efficiencies are not the result of well construction or design have not been supported with any substantive data or information. Although it may not be well design, it could be other factors related to well construction such as insufficient well development. EPA expects NW Natural to determine efficiency of these wells using whatever method is most appropriate because this information is vital for

evaluating where improvements in well design and/or well development can be made to operate the HC&C system in an effective manner that not only provides more certainty in meeting the remedial action objective (RAO), but also minimizes energy costs expended to operate this long-term remedial action. EPA notes that NW Natural proceeds at their own risk in moving forward with the implementation of the HC&C system without fully evaluating the cause and relationship of well losses in the existing extraction wells.

14. **Section 3.2.2.5.2, Capture Assessment**: EPA notes that the capture assessment narrative continues to appear severely limited and simplistic. This is based on the following which was highlighted in EPA's set of comments attached to DEQ's December 7, 2011 submittal (see Attachment B – EPA Specific Comments; Category 1, Item 30, EPA Comment 19). Concepts transmitted within this previous comment include the following:

    - Control wells were too close to extraction wells to verify reverse gradient conditions at locations in the aquifer further away from the extraction well.

    - Performance monitoring in the CDR needs a better explanation in terms of how and when hydraulic capture is assessed using data downloaded independently from the established monitoring wells/piezometers and integrated into the single control well.

    - NW Natural should include more wells, including offshore piezometers, in the real-time control of pumping rates and assessment of capture. Controlling the extraction well pumping rates with a single control well is too simplistic to ensure that hydraulic capture (as defined by a negative delta between upland groundwater heads and the river stage at all times) is achieved within the hydrostratigraphy that underlies the Gasco Site.

    Based on EPA's review of the revised CDR, no text has been added to clarify how selected monitoring wells will be used to maintain the necessary gradient reversals required for achieving the groundwater RAO (see Section 1-2). EPA understands this information is available from NW Natural's evaluation presented in the *Segment 2 Field Tests of the Programmable Logic Control and Variable Frequency Drive Well Pumps* document, dated May 2011. This evaluation included deltas between groundwater heads at various monitoring wells and piezometers and the river stage to determine if hydraulic control had been achieved. It is EPA's expectation that this assessment on all of these instrumented monitoring locations (shown in Table 3-5) will be made in real time and inform the pumping rates for the individual wells in the extraction system to ensure capture is being achieved at all times. It remains unclear how a single control well for each extraction well, as maintained in the revised CDR, will achieve that same level of real-time evaluation and certainty that hydraulic control is being achieved at all times. EPA recognizes that several monitoring wells are instrumented with sensors and dataloggers, but these appear to be only downloaded intermittently, so it begs the question how this information can be used to verify hydraulic control at all times. To be clear, learning that a gradient reversal was not achieved from upland pumping for several weeks after downloading, reducing, and

evaluating datalogger information is not real-time control. EPA's expectation is for NW Natural to present a detailed description of each control well, set points for controlling the pumps, how these set points were established, and how the control wells will ensure hydraulic control at capture assessment locations throughout the site and offshore to the extent of the FAMM dock is occurring at all times. Until this information is provided, EPA feels NW Natural is non-responsive to EPA's Comment 19 presented in the December 7, 2011 DEQ submittal.

In summary, there currently exists too much uncertainty regarding when instrumented monitoring wells and offshore piezometers will be evaluated to verify gradient reversals are being achieved. If not performed in real-time or used to control pumping rates, it would appear hydraulic control of groundwater discharge will only be assessed and corrected (if necessary) after a manual download of datalogger data and evaluation is performed. This is inconsistent with EPA's expectation that complete hydraulic capture of groundwater discharge through the site will be achieved and verified at all times. NW Natural should recognize that certainty of hydraulic control must be met with real-time assessment, not after months of unknown performance of the extraction system while data are collected, reduced, and evaluated from instrumented monitoring wells and offshore piezometers.

Appendix F - Groundwater Model Documents Comments

The following are EPA comments on the memorandum titled *NW Natural Gasco Site: Documentation of Groundwater Model Modifications Since 2008,* dated April 12, 2012, prepared by Anchor QEA, LLC on behalf of NW Natural. EPA understands this memorandum constitutes Appendix F – Groundwater Model Documents, which was not provided in the January 2012 CDR submittal.

General Comments

1. EPA notes that this memo addresses many of the outstanding requests for additional numerical groundwater model documentation (see comments EPA provided for the May 2010 Draft Final Design Report and attached in DEQ's September 22, 2011 letter). However, some comments have not been addressed. These include the following:

   a. **EPA Specific Comment 4**; *Section 3.2.1.4, page 19, paragraph 1, last bullet: Additional figures, as a result of additional modeling runs, as referenced in the bullet, do not appear in the report, or Appendix F where the groundwater modeling documents are presented. These simulations may be critical to the final design and should be provided for review.*

   NW Natural Response (November 4, 2011 letter): *The bullets reference specific documents prepared for ODEQ. These will be appended to the model documentation in the Construction Design Report.*

   b. **EPA Specific Comment 5**; *Section 3.2.1.4 page 20: Groundwater inflows shown in the table need to be broken out to present the components of flow in the horizontal as well as vertical direction. For instance, NW Natural should present how much flow contribution the Fill has to*

the Upper Alluvium and the Upper Alluvium to the Lower Alluvium. This will help quantify the amount of flow lost to the alluvium as a result of future site paving and the interceptor trench constructed in the fill WBZ. NW Natural should evaluate these changed conditions using the model and present the results (see General Comment 3).

NW Natural Response (November 4, 2011 letter): *Yes, this table will be revised and further explained in the Construction Design Report. Yes, this will be done and the findings described in the Construction Design Report.*

Furthermore, EPA presents additional comments specific to the analysis and conclusions presented by NW Natural in the April 12, 2012 memorandum (see Appendix F Specific Comments below).

2. NW Natural makes several statements that the numerical groundwater model is conservative in that it simulates greater groundwater flows than those that are believed to exist under actual site conditions. However, the supporting evidence that actual site conditions present lower groundwater flows is flawed in that the basis of evidence appears to be linked solely to a comparison of hydraulic conductivity. This is detailed further in the following paragraphs:

   a. NW Natural links under-predicted heads at MW-10-61, MW-14-110 and MW-15-66 to the assumption/extension of higher hydraulic conductivity (K) values assigned to the model extending upland. NW Natural implies an extension of higher K values in the upland direction is not realistic, but does not present evidence for this conclusion. EPA believes there are other hydraulic parameters, if set incorrectly, that can result in under-predicted heads (e.g., storage coefficients and vertical/horizontal recharge), yet none of these alternative factors appear to be described in the memorandum in relation to their sensitivity to modeled head conditions.

   b. NW Natural uses specific capacity derived from Segment 2 tested wells to derive hydraulic conductivity values that are assumed to be more accurate, and an order of magnitude lower, than current model assignments. NW Natural presents a case that this is a conservative approach and that the hydraulic conductivity assigned to the intermediate alluvium WBZ is too high. EPA is concerned with this analysis since the specific capacity value employed does not factor out well losses and the screen interval length was assumed for the entire aquifer thickness. EPA has noted previously that well losses were present in these extraction wells and that the screens do not fully penetrate the aquifer.

   For a complete evaluation of the "conservative" aspects of the model, NW Natural should evaluate and describe all factors that may be influencing groundwater heads (not just hydraulic conductivity). The analysis should also evaluate and describe factors contributing to bias within the presented pumping well data analysis (e.g., well losses) that might incorrectly point to lower K values than actual. As a result, the calibrated model and its predicted higher groundwater flows may be a more reasonable flow value that NW Natural

should prepare to control with the proposed HC&C system. In addition, NW Natural should recognize that the number of wells needed to control the model predicted groundwater flow may be under predicted because of inherent issues with individual well losses.

Specific Comments

1. **Expansion of the Groundwater Model to the U.S. Mooring Site Section:** NW Natural should present more information that supports the stated conclusion that the extension of the model area does not "significantly" change flow patterns on the Gasco Site. EPA expects this qualitative term to be supported with illustrations (e.g., gradient vector maps) showing flow patterns and magnitude under pre- and post-model domain extension.

2. **Model Grid Refinement, second paragraph:** The modeled head to observed head comparison scatter plots are difficult to follow with the text, which describes a spatially distributed comparison of groundwater heads throughout the site. NW Natural should supplement the head comparison scatter plots with maps showing calibration between modeled and observed heads at site specific well points. This will allow one to follow along with statements such as, "The calibration in the alluvium is better in the nearshore area where water levels are close to river stage and at the upland boundary." As currently presented, a reader cannot discern what alluvium scatter point is associated with a well located in the "nearshore area."

3. **Model Grid Refinement, second and third paragraphs, pages 3 and 4:** See EPA General Comment 2 with regards to the conservative aspects to the numerical model and HC&C design implied by NW Natural. A more elaborate explanation of how these differences present a conservative approach to HC&C design is needed. NW Natural should evaluate the root cause for the discrepancy between modeled and calculated site groundwater flow since there are other model parameters besides hydraulic conductivity that can present variability in groundwater heads.

4. **Refinement of Shallow Alluvium Hydraulic Conductivity, first paragraph, page 4:** EPA notes a range of transmissivity values have been determined for three wells completed in the shallow alluvium WBZ. However, NW Natural should reference the document that shows the analyses that were used to derive them. Furthermore, an explanation of the large variability in transmissivity values for each well should be provided, if not provided in the source document.

5. **Deep Aquitard, first paragraph, second sentence, page 7:** NW Natural should present information that supports their conclusion that the deep aquifer "has a limited areal extent both upland and offshore." This appears to contradict a major study near the Gasco Site (i.e., Starlink Logistics 2010 Draft RI/SCE Report) which presents evidence of a channel of coarse grained Alluvial/Colluvial gravel deposits that connect this deep aquifer to upland areas towards the southeast well beyond the limits shown in Figure 5. If present, groundwater discharge through this more aerially extensive permeable aquifer may be

greater than anticipated, and currently modeled, by NW Natural resulting in the inability to capture groundwater discharging through this layer with the current HC&C design.

6. **Deep Aquitard, last paragraph, page 7:** NW Natural should explain how they determined that the horizontal discharge through the deep aquifer is less than vertical discharge and what the anticipated horizontal groundwater flow to vertical flow in the deep aquifer is. As recommended in EPA's *Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems,* EPA 600-R-08-003, January 2008 (see page 14), NW Natural should present this information with flow vector arrows that represents the average flow rate and direction for each model grid cell. Furthermore, NW Natural should present the groundwater discharge in the deep aquifer that the scenario in Figure 6 is based on and evaluate whether or not this is achievable under higher groundwater flow rates, especially given the evidence from a neighboring upland property conceptual site model (see Appendix F, Specific Comment 5) that this deep aquifer is more extensive than assumed in NW Natural's groundwater model.

7. **Deep Aquitard, last sentence, last paragraph, page 8:** NW Natural should provide more detail and explanation of the alternative analysis using gradient and conductance to determine whether wells or the river is the least resistant flow path. To clarify, EPA assumes NW Natural is referring to specific conductivity when using the term "conductance." As written, is not clear how these parameters will be used to verify the capture of deep groundwater using the intermediate alluvium zone HC&C wells.

8. **Additional Design Features: Fill WBZ Interceptor Trench and Site Paving, first sentence, first paragraph, page 8:** NW Natural should explain how the 2-inches per year of infiltration through paved areas was derived.

9. **Additional Design Features: Fill WBZ Interceptor Trench and Site Paving, last sentence, first paragraph, page 9:** NW Natural should explain how "the Siltronics property and former Doane Lake area contribute more groundwater flow to the Gasco property as recharge is reduced." This explanation should include a description of model assumptions that may factor into a constant supply of groundwater (e.g., through modeled head boundaries) that may not be realistic for site conditions at certain times of the year. Furthermore, NW Natural should provide the quantity of additional groundwater flow from Siltronics and the former Doane Lake area and the supporting analysis that this statement is based on.

10. **Additional Design Features: Fill WBZ Interceptor Trench and Site Paving, last sentence, second paragraph, page 9:** NW Natural should present how much water levels decreased on the upland side of the trench, as well as the hydraulically downgradient side. As currently written, a reader does not know what level the water levels decreased to from the "approximately 20 feet level on the upland side of the trench", or what "nearly river level" is in relation to ground surface hydraulically downgradient of the trench. A simplified cross-section would be better suited to present this information.

11. **Additional Design Features: Fill WBZ Interceptor Trench and Site Paving, second to last paragraph, page 9:** NW Natural should present more of the analysis that was used to support the bulleted statements. EPA finds it difficult to believe the "Fill WBZ interceptor trench does not dewater the fill upland of the trench" to some degree and reduce recharge to the upper alluvial aquifer that might in turn affect the performance of the upper alluvial HC&C wells. As currently written, there is no presentation of evidence that leads EPA to believe with certainty that site paving and the interceptor trench will not impact the available drawdown and capacity of the upper alluvium wells.

12. **Simulation of the Variable Rate Pumping Test, pages 9-14**: EPA understands the purpose of a control well is to control a VFD pump in a specific extraction well. However, EPA believes a control well and the delta between it and the river stage is not the definitive assessment of whether or not hydraulic control of groundwater discharging under the site to the river is being achieved. For this assessment, the network of upland and offshore monitoring locations shown in Table 3-5 of the January 2012 CDR should be evaluated in real-time to verify that a gradient reversal is being achieved for all flow paths within the hydrostratigraphic layers underneath the Gasco Site. EPA feels this is an important distinction between the role of the control wells for controlling VFDs and the overall confirmation that the groundwater RAO is being met.

13. **Simulation of the Variable Rate Pumping Test, last two paragraphs page 14:** See Appendix F, General Comment 2. EPA has a concern with NW Natural's analysis using specific capacity to estimate hydraulic conductivity. This analysis does not factor out well losses in the specific capacity assignment in the equation and the use of the well screen interval for aquifer thickness greatly underestimates the thickness of the aquifer. Therefore, the comparison between calculated and modeled site hydraulic conductivity conditions cannot be made with any degree of confidence. NW Natural should re-evaluate this, incorporating well losses and the full thickness of the aquifer.